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(54) **DEEP HOLE DRILL**

TIEFLOCHBOHRER

FORET POUR TROU PROFOND

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WO-A1-95/34397 **US-A- 1 304 981**
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Description

[0001] The present invention relates to a deep hole drill, which comprises a cutter head as well as a connecting part integrated with the cutter head which part has a thread, said cutter head being equipped with a chip removing cutting insert, at least one support pad as well as at least one guide bar, the said cutter head has at least one opening for discharging chips, said opening transforming into an inner channel of the cutter head. Such a deep hole drill is, according to the preamble of claim 1, e.g. known from WO 95/34397 A. The two most common systems in deep hole drilling are presently the STS (Single Tube System) system and the Ejector system. the present invention relates to both these systems.

Prior art

[0002] In deep hole drilling, a commonly occurring problem is that the support pads and guide bars, which are arranged on the cutter head, are subjected to the formation of crack, during the deep hole drilling. The reason for this is that the support pads/guide bars are normally made of solid cemented carbide, whereby said support pads/guide bars may be exchangeably fixed on the cutter head or in various ways connected by soldering to the cutter head. During the drilling process, the support pads/guide bars are exposed to high temperatures by the fact that the friction against the hole wall may be high. However, it is most often so that the entire support pad/guide bar does not abut against the hole wall, and therefore only a part of said support pad/guide bar is exposed to said friction. The cooling liquid flowing between the cutter head and the bore hole will not be in contact with the support pad/guide bar in those areas where abutment takes place between the support pad/guide bar and the hole wall to a sufficient extent. As a consequence of these interacting circumstances, i.e. high friction and deficient cooling, cracks arise in the support pads/guide bars, which reduce the service life of said support pads/guide bars.

Aims and features of the invention

[0003] The present invention has as its aim the definition of a deep hole drill of the kind mentioned in the introduction, where the cooling liquid is given a greater possibility to provide cooling of the support pad/guide bar, in an efficient way, during drilling.

[0004] Yet another aim of the invention is to improve the chip removal, which reduces the risk for chips being stuck between the support pad/guide bar and the hole wall, which additionally may reduce the service life of said support pads/guide bars.

[0005] The aims of the present invention are realised by means of a deep hole drill having the features mentioned in the subsequent claims. Preferred embodi-

ments of the invention are defined in the dependent claims.

Brief description of the drawings

[0006] Below an embodiment of the invention will be described, reference being made to the accompanying drawings, where

- 5 Fig 1 shows a front view of a deep hole drill according to prior art;
- Fig 2 shows a front view of an embodiment of a deep hole drill according to the present invention;
- 10 Fig 3 shows a perspective view obliquely from below of the deep hole drill according to Fig 2;
- Fig 4 shows a perspective view obliquely from above of the deep hole drill according to Fig 2;
- 20 Fig 5 shows a front view of the deep hole drill according to Fig 2, where the resultant of the cutting forces as well as the forces acting on the support pad and the guide bars are indicated;
- 25 Fig 6 shows schematically the surface, which lets through cooling liquid on a deep hole drill according to prior art;
- 30 Fig 7 shows schematically the surface which lets through cooling liquid on a deep hole drill according to the present invention; and
- 35 Fig 8 shows a perspective view of an alternative embodiment of a deep hole drill according to the present invention.

Description of prior art as well as a first embodiment of a deep hole drill according to the present invention

[0007] The deep hole drill A according to the prior art illustrated in fig 1 is provided with a support pad B and a guide bar C. In that connection, no special arrangements are taken to overcome the problems which have been discussed above under the heading Prior art, i.e. that the support pad B and the guide bar C are subject to crack formation.

[0008] The deep hole drill according to the present invention illustrated in figs 2-5 comprises a cutter head 1 as well as a connecting part 3 integrated with the cutter head 1, which connecting part is provided with an external thread 5. The connecting part 3 is connected to a drill tube (not shown), via said external thread 5, which in turn is carried by a suitable supporting device.

[0009] The cutter head 1 is, in the usual way, equipped with cutting inserts 7, these however not being described in detail since they do not constitute a part of

the present invention. Furthermore, the cutter head 1 is provided with a support pad 9 and a guide bar 10, which in the embodiment illustrated consist of exchangeable units according to the principle of indexable inserts. As is most clearly seen in Fig 3, the support pad 9 and the guide bar 10 are provided with chamfers 11 and 12, respectively, at the end thereof turned towards the connecting part 3. In that connection, the chamfers 11, 12 are so formed that their abutment against the cutter head 1 takes place without there being any difference in level between the chamfers 11, 12 and the portions of the cutter head 1 which said chamfers 11, 12 abut against.

[0010] The cutter head 1 of the deep hole drill according to the present invention is also provided with a first cooling duct 13 and a second cooling duct 14, the first cooling duct 13 being situated adjacent to the support pad 9 while the second cooling duct 14 being situated adjacent to the guide bar 10. Said cooling ducts 13, 14 extend in the axial direction of the deep hole drill and are preferably parallel to the axial direction of the deep hole drill. In the embodiment illustrated, the cooling ducts 13, 14 are formed as concave countersinks in the cutter head 1, the cooling ducts having, when seen in cross-section, a softly rounded bottom with a certain radius of curvature.

[0011] The cutter head 1 is provided, in the usual way, with an inner channel for discharging the chips produced during the rotation of the cutter head 1 in relation to the workpiece. In that connection, the cutter head 1 is provided with a first opening 15, through which the majority of the chips produced are discharged, said first opening 15 being connected to the interior channel of the cutter head 1. The cutter head 1 has also a second opening 16, which also is used to discharge chips, said second opening 16 also being in connection with the interior channel. In the illustrated embodiment, the first opening 15 is somewhat larger than the second opening 16.

The function of the deep hole drill according to the invention

[0012] In conjunction with a hole being drilled in a work-piece, this is clamped in a kind of fixture while the deep hole drill with the drill tube thereof is clamped in a rotatable chuck, and then the workpiece and the deep hole drill are pressed up against each other. The deep hole drill with the drill tube thereof is then brought to rotate and is displaced axially in relation to the workpiece, a hole being drilled in said workpiece. During the drilling process, the support pad 9 and the guide bar 10 abut against the hole wall, whereby a temperature rise takes place in the support pad 9 and the guide bar 10 by virtue of the friction against the hole wall. In this connection, reference is made to fig 5 which, on one hand, shows the resultant R of the radial cutting forces exerted by the cutting inserts 7 and, on the other hand, the forces acting from the hole wall on the support pad 9 and the guide

bar 10 which compensate said resultant R. Then, it should be noted that force F1 acting on the support pad 9 is larger than the force F2 acting on the guide bar 10. As a result of this force distribution, the support pad 9 is exposed to a larger friction and thereby also a greater temperature rise.

[0013] In order to compensate for said temperature rise, cooling medium, commonly oil, is supplied into the space between the drill tube of the deep hole drill and the hole wall when an STS system is concerned, said cooling medium being brought to flow in the direction towards the cutter head 1. When the cooling medium reaches the cutter head 1, an accumulation of cooling medium takes place in the first and second cooling duct 13 and 14, respectively, the main part of the cooling medium flowing to the free chip removing end of the cutter head 1 via the first and second cooling ducts 13 and 14, respectively. Since the cutter head 1 rotates in the direction of the arrow S, see fig 5, i.e. the support pad 9 is to be found behind the first cooling duct 13 in the direction of rotation, said support pad 9 will pass through the accumulation of cooling medium which is generated by the first cooling duct 13. Thereby, a significantly improved cooling of the support pad 9 is achieved in comparison with the cooling which is obtained for a deep hole drill according to prior art.

[0014] It is true that a corresponding cooling of the guide bar 10 is not obtained, but an equally satisfactory cooling of the guide bar 10 is not required since the same it is exposed to a force F2 from the hole wall which is significantly smaller than the force F1 which the support pad 9 is exposed to.

[0015] In figs 6 and 7, the difference in volume of cooling medium reaching the chip removing end of the cutter head 1 is schematically illustrated for a deep hole drill according to prior art, fig 6, and for a deep hole drill according to the present invention, fig 7. The dashed surfaces in figs 6 and 7 represent the surfaces that are available for the cooling medium to flow forward in. For a deep hole drill according to prior art, see fig 6, the available surface is approx. 12 % of the cross-section area of the drilled hole, while for a deep hole drill according to the present invention, see fig 7, the available surface for the cooling medium is approx. 15 %. This equals an increase of approx. 20 % when comparing deep hole drill according to prior art and a deep hole drill according to the present invention.

[0016] The increased volume of cooling medium which reaches the chip removing end of the cutter head 1 is, naturally, positive for the chip removal since the cooling medium turns at the chip removing end and pulls the chips with it through the first opening 15 and the second opening 16. The fact that the second cooling duct 14 is situated quite in front of the first opening 15, seen in the direction of rotation S, see fig 5, of the cutter head 1, ensures that an accumulated volume of cooling medium can turn back and flow through the first opening 15, said accumulated volume of cooling medium in an

efficient way pulling chips with it from the chip removing end of the cutter head 1. The cooling medium then continues in the interior channel of the deep hole drill and further inside in the appurtenant drill tube (not shown).

Alternative embodiment of a deep hole drill according to the present invention

[0017] The deep hole drill illustrated in fig 8 comprises, like the embodiment according to figs 3-5, a cutter head 1' as well as a fastening part 3, which in principle is identical with the fastening part 3 of the embodiment illustrated in figs 3-5. The design of the cutter head 1' is what distinguishes the deep hole drill according to fig 8 from the deep hole drill according to figs 3-5, and more precisely the arrangement of an additional cooling duct 17', i.e. a third cooling duct, which is situated besides and quite close to the guide bar 10. Thus, the deep hole drill according to fig 8 is provided with a first and a second cooling medium duct 13 and 14, respectively, which is seen in fig 8. If the same direction of rotation is valid for the deep hole drill according to fig 8 as the deep hole drill according to figs 3-5, see arrow S in fig 5, the third cooling duct 17' is positioned in front of the guide bar 10 in said direction of rotation S. Said third cooling duct 17' should guarantee that the guide bar 10 receives a satisfactory cooling/lubrication by the cooling medium flowing in the third cooling duct 17'. Normally, the third cooling duct 17' has smaller dimensions than the first and second cooling ducts 13 and 14.

Feasible modifications of the invention

[0018] In the embodiment described above, two cooling ducts 13, 14 are arranged on the circumference of the cutter head 1. However, within the scope of the invention, it is feasible that only one cooling duct is arranged on the circumference of the cutter head 1, the cooling duct 13 which is arranged adjacent to the support pad 9, in that case, being preferable. The reason for this is seen in the description above when the cooling of the support pad 9 is discussed.

[0019] In the embodiment described above, the two cooling ducts 13, 14 are shown having in the main the same flow cross-section in fig 2. However, within the scope of the present invention, it is conceivable that, for instance, the second cooling duct 14 has a larger flow cross-section than the first cooling duct 13 since said second cooling duct 14 should serve two cutting inserts, i.e. let cooling medium pass which discharges chips from two cutting inserts.

[0020] In the embodiment described above, the support pad 7 and the guide bar 9 are in the form of exchangeable units according to the principle of indexable inserts. However, within the scope of the invention, it is feasible that the support pad/guide bar is connected by soldering to the cutter head 1 of the deep hole drill.

[0021] In the description above of the function of the

deep hole drill according to the invention, it has been assumed that the so-called STS system is used. However, a deep hole drill according to the present invention may also be used, which has been pointed out in the introduction of this patent application, in, for instance, the so called Ejector system or other existing systems for deep hole drilling. In the Ejector system, double drill tubes are used, approximately half of the cooling medium turning around before it reaches the chip removing end of the cutter head 1 and thereby providing an Ejector effect which activates the cooling medium reaching the chip removing end and transports chips with it on its way from the chip removing end.

[0022] In the above description of the function of the deep hole drill according to the invention, the deep hole drill is rotated while the workpiece is not rotated. However, it is also feasible, within the scope of the invention as defined by the appended claims, that the workpiece rotates while the deep hole drill do not rotate but only is axially displaced in relation to the workpiece. According to an additional variant, it is conceivable that both the deep hole drill and the workpiece rotate in opposite directions.

[0023] Reference being made to fig 7, it should be pointed out that the dashed cross-section surface besides the cooling ducts, being concave in cross-section, may, within the scope of the invention as defined by the appended claims, be blocked for cooling medium, at which said blocking member may consist of fibre strips or the like, applied on the outside of the cutter head. By such an arrangement, the cooling medium is forced to flow only in said cooling ducts, at which an additionally improved cooling of the support pad/guide bar may be counted upon.

Claims

1. Deep hole drill, which comprises a cutter head (1; 1') as well as a connecting part (3) integrated with the cutter head (1; 1'), which part is intended to be connected to a drill tube, said cutter head (1; 1') being equipped with a chip removing cutting insert (7), at least one support pad (9) as well as at least one guide bar (10), that said cutter head (1) has at least one opening (15, 16) for discharging chips, said opening (15, 16) transforming into an inner channel of the cutter head (1; 1'), **characterized in, that** at least one cooling duct (13) is arranged on the circumference of the cutter head (1; 1'), which cooling duct extends in the axial direction of the deep hole drill, and that the cooling duct (13) is arranged adjacent to the support pad (9).
2. Deep hole drill according to claim 1, **characterized in, that** the cooling duct (13) is arranged in front of the support pad (9), seen in the direction of rotation of the deep hole drill, or behind the support pad (9),

seen in the direction of rotation of the workpiece in case the deep hole drill does not rotate.

3. Deep hole drill according to one of the preceding claims, **characterized in, that** two cooling ducts (13, 14) are arranged on the circumference of the cutter head (1), and that the second cooling duct (14) also extends in the axial direction of the deep hole drill. 5
4. Deep hole drill according to claim 3, **characterized in, that** the second cooling duct (14) is arranged adjacent to the guide bar (10). 10
5. Deep hole drill according to claim 4, **characterized in, that** the second cooling duct (14) is arranged behind the guide bar (10), seen in the direction of rotation of the deep hole drill, or in front of the guide bar (10), seen in the direction of rotation of the workpiece in case the deep hole drill does not rotate. 15
6. Deep hole drill according to one of the preceding claims 4-5, **characterized in, that** the second cooling duct (14) has a larger flow cross-section than the first cooling duct (13). 20
7. Deep hole drill according to one of the preceding claims, **characterized in, that** the cooling duct (13) the cooling ducts (13, 14) consist/consists of concave countersinks having a softly rounded bottom with a certain radius of curvature. 25
8. Deep hole drill according to one of the preceding claims, **characterized in, that** the cutter head (1') is provided with a cooling duct (17') in direct proximity to the guide bar (10). 30
9. Deep hole drill according to claim 8, **characterized in, that** said cooling duct (17') is arranged in front of the guide bar (10), seen in the direction of rotation of the deep hole drill, or behind the guide bar (10), seen in the direction of rotation of the workpiece in case the deep hole drill does not rotate. 35

Patentansprüche

1. Tieflochbohrer, welcher einen Schneidkopf (1; 1') als auch einen Verbindungsteil (3), der integrierender Bestandteil des Schneidkopfes (1; 1') ist, umfaßt, wobei dieser Teil an eine Bohreröhre angeschlossen werden soll, wobei der Schneidkopf (1; 1') mit einem spanabhebenden Einsatz (7), wenigstens einer Stützunterlage (9) als auch wenigstens einem Führungsstab (10) ausgestattet ist, wobei der Schneidkopf (1) wenigstens eine Öffnung (15, 16) für die Entfernung von Spänen hat und wobei die Öffnung (15, 16) in einen inneren Kanal des 40

Schneidkopfes (1; 1') übergeht, **dadurch gekennzeichnet, daß** wenigstens eine Kühlleitung (13) an dem Umfang des Schneidkopfes (1; 1') angeordnet ist, wobei sich die Kühlleitung in der axialen Richtung des Tieflochbohrers erstreckt, und daß die Kühlleitung (13) nahe an der Stützunterlage (9) angeordnet ist.

2. Tieflochbohrer nach Anspruch 1, **dadurch gekennzeichnet, daß** die Kühlleitung (13), in der Drehrichtung des Tieflochbohrers betrachtet, vor der Stützunterlage (9), oder, für den Fall, daß der Tieflochbohrer sich nicht dreht, in der Drehrichtung des Werkstücks betrachtet, hinter der Stützunterlage (9) angeordnet ist. 10
3. Tieflochbohrer nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** zwei Kühlleitungen (13, 14) an dem Umfang des Schneidkopfes (1; 1') angeordnet sind, und daß die zweite Kühlleitung (14) sich ebenfalls in der axialen Richtung des Tieflochbohrers erstreckt. 15
4. Tieflochbohrer nach Anspruch 3, **dadurch gekennzeichnet, daß** die zweite Kühlleitung (14) in der Nähe des Führungsstabs (10) angeordnet ist. 20
5. Tieflochbohrer nach Anspruch 4, **dadurch gekennzeichnet, daß** die zweite Kühlleitung (14), in der Drehrichtung des Tieflochbohrers betrachtet, hinter dem Führungsstab (10), oder, für den Fall, daß der Tieflochbohrer sich nicht dreht, in der Drehrichtung des Werkstücks betrachtet, vor dem Führungsstab (10) angeordnet ist. 25
6. Tieflochbohrer nach einem der vorhergehenden Ansprüche 4-5, **dadurch gekennzeichnet, daß** die zweite Kühlleitung (14) einen größeren Fließquerschnitt hat als die erste Kühlleitung (13). 30
7. Tieflochbohrer nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die Kühlleitung (13)/die Kühlleitungen (13, 14) aus konkaven Spitzsenken mit einem leicht abgerundeten Boden mit einem bestimmten Krümmungsradius besteht/bestehen. 35
8. Tieflochbohrer nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** der Schneidkopf (1') mit einer Kühlleitung (17') in direkter nächster Nähe zu dem Führungsstab (10) ausgestattet ist. 40
9. Tieflochbohrer nach Anspruch 8, **dadurch gekennzeichnet, daß** die Kühlleitung (17'), in der Drehrichtung des Tieflochbohrers betrachtet, vor dem Führungsstab (10), oder, für den Fall, daß der Tieflochbohrer sich nicht dreht, in der Drehrichtung des 45

Werkstücks betrachtet, hinter dem Führungsstab (10) angeordnet ist.

Revendications

1. Foret pour trou profond, comprenant une tête de coupe (1 ; 1') ainsi qu'une partie de connexion (3) intégrée dans la tête de coupe (1 ; 1'), cette partie étant prévue pour être reliée à un tube de perçage, la tête de coupe (1 ; 1') étant équipée d'une plaquette de coupe par enlèvement de copeaux (7), d'au moins un patin support (9) ainsi qu'au moins une barre de guidage (10), la tête de coupe (1) ayant au moins une ouverture (15, 16) d'évacuation de copeaux, l'ouverture (15, 16) se transformant en un canal interne de la tête de coupe (1 ; 1'), **caractérisé par le fait qu'**au moins un conduit de refroidissement (13) est situé sur la circonférence de la tête de coupe (1 ; 1'), ce conduit de refroidissement s'étendant dans la direction axiale du foret pour trou profond, et que le conduit de refroidissement (13) est situé de façon adjacente au patin support (9). 20
2. Foret pour trou profond selon la revendication 1, **caractérisé par le fait que** le conduit de refroidissement (13) est situé devant le patin support (9), en vue dans la direction de rotation du foret pour trou profond, ou derrière le patin support (9), en vue dans la direction de la pièce à usiner dans le cas où le foret pour trou profond ne tourne pas. 25 30
3. Foret pour trou profond selon l'une des revendications précédentes, **caractérisé par le fait que** deux conduits de refroidissement (13, 14) sont situés sur la circonférence de la tête de coupe (1), et que le second conduit de refroidissement (14) s'étend aussi dans la direction axiale du foret pour trou profond. 35 40
4. Foret pour trou profond selon la revendication 3, **caractérisé par le fait que** le second conduit de refroidissement (14) est situé de façon adjacente à la barre de guidage (10). 45
5. Foret pour trou profond selon la revendication 4, **caractérisé par le fait que** le second conduit de refroidissement (14) est situé derrière la barre de guidage (10), en vue dans la direction de rotation du foret pour trou profond, ou devant la barre de guidage (10), en vue dans la direction de rotation de la pièce à usiner dans le cas où le foret pour trou profond ne tourne pas. 50
6. Foret pour trou profond selon l'une des revendications précédentes 4 et 5, **caractérisé par le fait que** le second conduit de refroidissement (14) a une section transversale de passage plus grande 55

que le premier conduit de refroidissement (13).

7. Foret pour trou profond selon l'une des revendications précédentes, **caractérisé par le fait que** le ou les conduits de refroidissement (13 ; 13, 14) consistent en des fraisages concaves ayant un fond doucement arrondi avec un certain rayon de courbure. 5
8. Foret pour trou profond selon l'une des revendications précédentes, **caractérisé par le fait que** la tête de coupe (1') comporte un conduit de refroidissement (17') à proximité directe de la barre de guidage (10). 10 15
9. Foret pour trou profond selon la revendication 8, **caractérisé par le fait que** le conduit de refroidissement (17') est situé devant la barre de guidage (10), en vue dans la direction de rotation du foret pour trou profond, ou derrière la barre de guidage (10), en vue dans la direction de rotation de la pièce à usiner dans le cas où le foret pour trou profond ne tourne pas. 20 25 30 35 40 45 50 55

Fig. 1

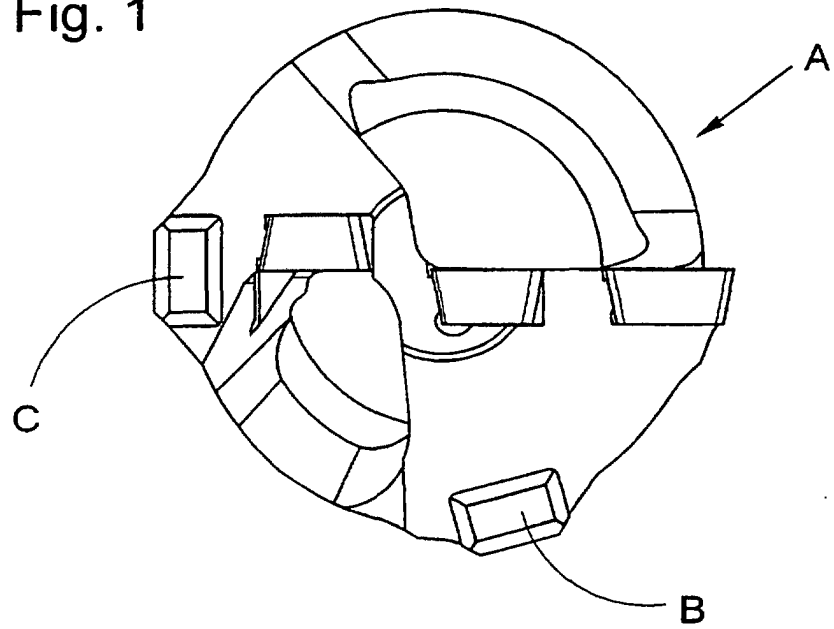


Fig. 2

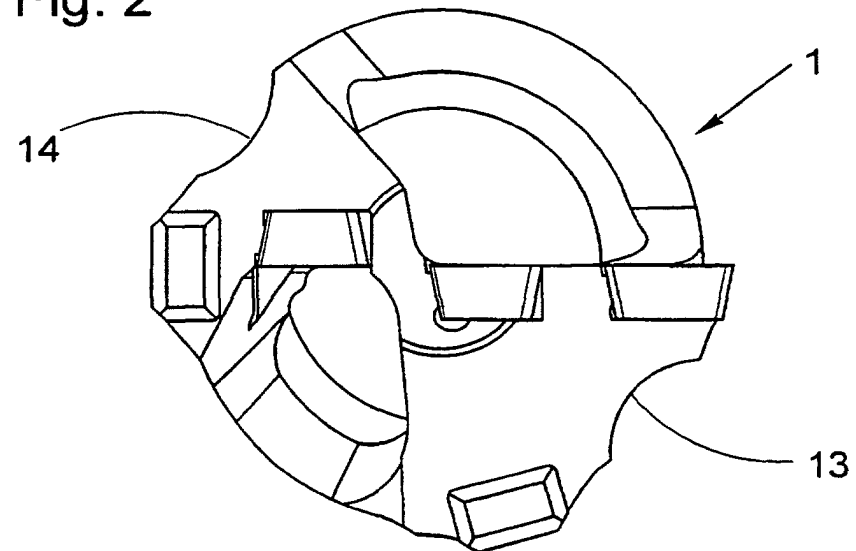
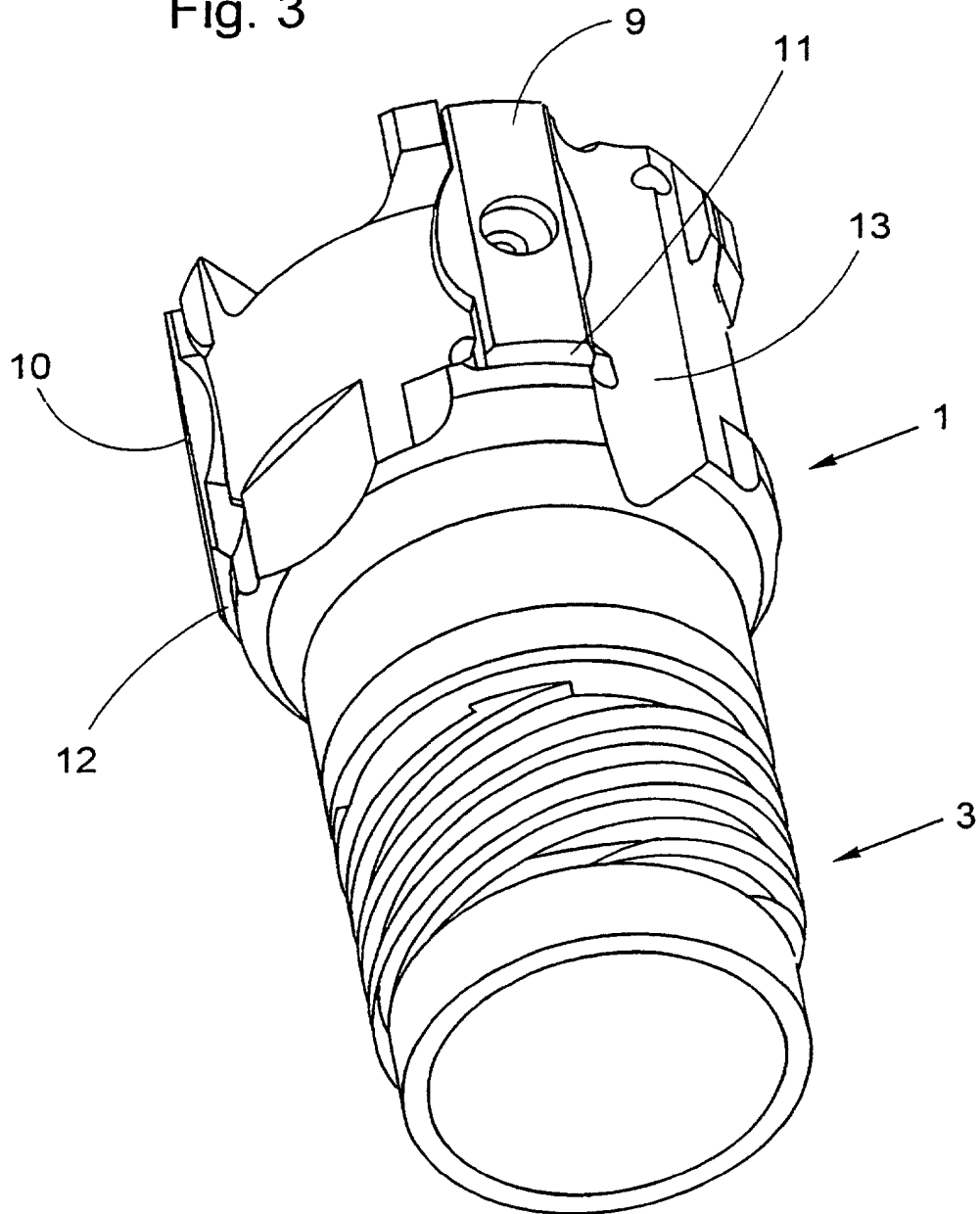


Fig. 3



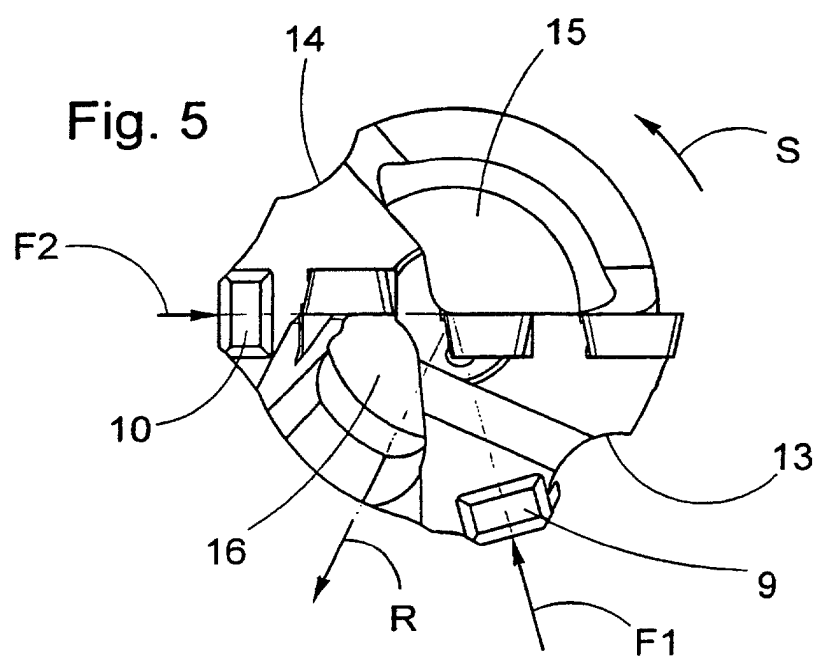
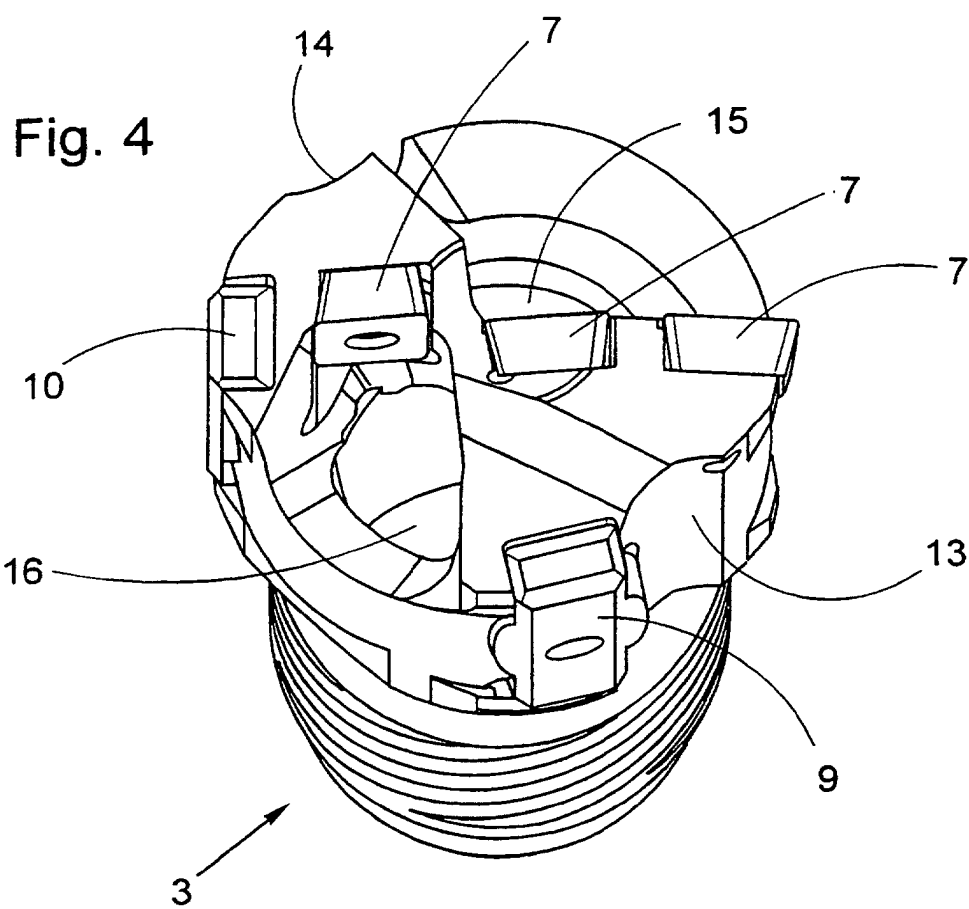


Fig. 6

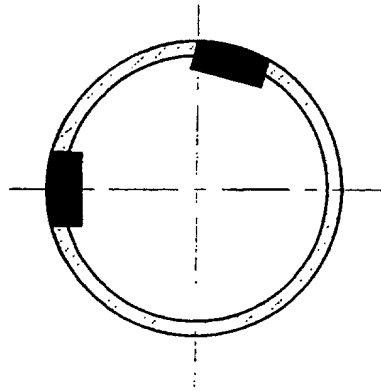


Fig. 7

